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Design of Project-Based Task Management System on Moodle for Computational Thinking Improvement

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Abstract. This study investigates the development of an E-learning platform, "Eduframe," based on Moodle and integrated with a Task Management System (TMS), employing a project-based learning approach to improve students' computational thinking skills. The ADDIE model, which is comprised of analysis, design, development, implementation, and evaluation, was used to develop the platform. The results revealed significant improvements in students' computational thinking skills when using the "Eduframe" website compared to traditional learning methods. The experimental group demonstrated higher scores in computational thinking (post-test score: 86.94) and computational thinking project performance (86.94) compared to the control group (computational thinking post-test score: 72.33; computational thinking project post-test score: 75.06). The hypothesis test indicated a significant difference, with a Sig. (2-tailed) value of 0.001 < 0.05, suggesting that H0 is rejected, confirming the effectiveness of the "Eduframe" application in improving computational thinking skills in web programming among class XI RPL students at SMKN 2 Surabaya.

Keywords: Computational Thinking; Education Technology; E-learning; Learning Management System; Moodle; Project Based Learning; Task Management System

1. Introduction

The development of technology worldwide continues to occur rapidly. Moreover, it affects various parts of life, including schools. Learning through technology emphasizes the importance of technology as a significant component integrated into learning programs and activities. Without technology, the desired curriculum and learning experience cannot be achieved (Liang and Law, 2022).

The integration of technology in education opens an excellent opportunity to utilize the LMS (Learning Management System) platform as a tool that can facilitate the management, provision, and organization of online learning (Priambudi *et al.*, 2023). It also opens the door for the development of innovative and effective learning methods, enables more accurate evaluation of learning progress, and improves administrative efficiency in education management (Mahliza *et al.*, 2023). In addition, the use of LMS also enables cooperation among educators and learners in developing experiences (Ayu Puspita and Amelia, 2020). Students can access materials flexibly, follow learning activities tailored to their needs, and participate in online discussions that enrich their understanding of specific topics (Paetsch *et al.*, 2023).

Based on the results of pre-research involving observations and interviews during the Introduction to the School Environment (PLP) activities at SMKN 2 Surabaya, researchers found several problems in learning web programming subjects in class XI RPL. One of them is the lack of structure and neatness in the packaging of the material, which disrupts the effectiveness of material delivery, and students find it challenging to understand the material presented. The results of interviews with students also revealed that meetings between students and teachers do not always occur, especially if the teacher is not present in class. This becomes an obstacle in the learning process, especially for students who need more detailed explanations. To overcome this problem, face-to-face and distance learning methods can be an effective solution (Eija *et al.*, 2024). With this framework, materials can be updated effectively, and teachers allow access anytime and anywhere, thus supporting learning and teaching activities (Utomo, 2023).

Distance learning and E-learning have become increasingly relevant topics in the modern educational context. In E-learning activities, students can share their knowledge and experience through Online learning platforms such as Moodle (Angreanisita and Mastur, 2021). Moodle is an example of a Learning Management System (LMS) that enables interaction and collaboration between learners (Chen *et al.*, 2023). In addition, Moodle, as a Learning Management System (LMS), has the flexibility and ability to integrate various plugins or extensions that can support multiple learning styles, including project-based learning styles. The researcher decided to use project-based learning in Moodle E-learning because this model can encourage students to engage in actual project activities effectively, allow for hands-on application of learned concepts, and facilitate the development of collaboration, problem-solving, and creativity skills (Alhayat *et al.*, 2023). Thus, proper integration of Plugins in Moodle can transform it into a highly supportive learning environment and facilitate various important aspects of project-based learning (Angga *et al.*, 2022).

This study aims to develop the "Eduframe" E-learning platform, integrated with a Task Management System (TMS) and employing a project-based learning approach to enhance students' computational thinking skills in web programming. The findings indicate a significant improvement in computational thinking skills among the experimental group, as demonstrated by higher post-test and project scores compared to the control group. Statistical analysis with a Sig. (2-tailed) value of 0.001 < 0.05 confirms the effectiveness of the "Eduframe" platform in improving computational thinking skills in web programming.

2. Methods

This research employs the ADDIE development model, which consists of five stages: Analysis, Design, Development, Implementation, and Evaluation (Geni *et al.*, 2020). This model was chosen due to its systematic approach, allowing for iterative design and continuous improvement throughout the development process. By following these stages, the research ensures that the development process is structured and comprehensive, allowing for effective integration of the Task Management System (TMS) and project-based learning approach in the E-learning platform. A visualization of the ADDIE stages is shown in Figure 1.

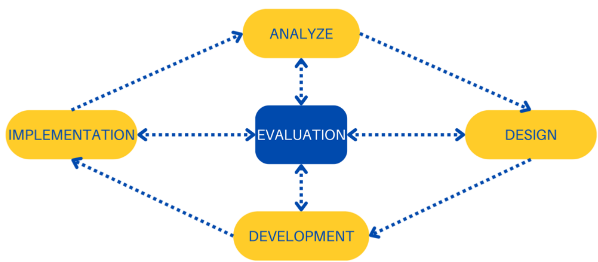

Figure 1 Development phases in the ADDIE model

The participants in this research were randomly divided into two classes, with XI RPL 2 being the experimental class using Eduframe E-learning Website and XI RPL 1 being the control class using the classical learning approach, hence the post-test only. Table 1 provides an overview of the research design.

Table 1 Product test scheme

R	S_1	Y	S_2

Description:
R: Group retrieval
S1: Post-test results of the experimental class
Y: Treatment of the experimental class
S2: Post-test results of the control class

2.1. Population And Sample

The population recorded in this research consisted of 2 XI classes in the Software Engineering (RPL) program at SMKN 2 Surabaya, totaling 72 students, with each class containing 36 students.

2.2. Validation Assessment Analysis

The validity of the learning media is declared valid based on the suitability of the validation results between the validator and the predetermined validity criteria. The criteria for scoring the answers to the validation sheet are shown in Table 2 illustration:

Table 2 Validation assessment categories

Score	Criteria
5	Very Good (VG)
4	Good (G)
3	Good Enough (GE)x
2	Not Good (NG)x
1	Very Bad (VB)x

Based on the results of the validation evaluation that have been analyzed, the formula for calculating the percentage of validity from filling out the validation sheet is presented in Equation 1, and then the categories are presented in Table 3.

$$Validity\ Score = \frac{Total\ score\ obtained}{Total\ maximum\ score}\ x\ 100\%$$

Table 3 Validation percentage category

Percentage	Category
82%< x ≤ 100%	Very Valid
63% < x ≤ 81%	Valid
44% < x ≤ 62%	Less Valid
25% < x ≤ 43%	Not Valid

2.3. Analysis of Differences in Computational Thinking Ability

The analysis described, including the normality test, homogeneity test, and hypothesis test (which refers to the independent sample t-test), is used primarily in the Evaluation stage of the ADDIE model. The Evaluation stage comes after the implementation of the E-learning platform and the collection of data (post-test scores), as this stage is focused on assessing the effectiveness of the intervention. This is when the researcher tests the hypothesis and determines whether the E-learning platform, integrated with the Task Management System (TMS), improved students' computational thinking skills.

<u>2.3.1. Normality Test</u>

Normality testing is done to check the normality of the distribution of each variable. This test was conducted using the Kolmogorov-Smirnov and Shapiro-Wilk methods.

2.3.2. Homogeneity Test

Homogeneity testing is carried out to evaluate the similarity of variance in the data sample under study. The homogeneity test uses the Levene test by comparing the maximum and minimum variances of the data.

2.3.3. Hypothesis Test

The hypothesis test, specifically the t-test, is applied in this study because it uses a post-test-only design. In a post-test-only design, there is no pre-test data, so the only measure to compare is the post-test score. The t-test determines whether the observed difference between the experimental and control groups is statistically significant, helping to validate the impact of the intervention. It allows researchers to reject or fail to reject the null hypothesis, indicating whether the E-learning platform significantly improved computational thinking skills. The hypothesis in this research is defined as follows:

H0: There is no difference in students' computational thinking skills in web programming subjects after using TMS (Task Management System) based on E-learning Moodle with a project-based learning model.

H1: There is a difference in students' computational thinking skills in web programming subjects after using TMS (Task Management System) based on E-learning Moodle with a project-based learning model.

3. Results and Discussion

3.1. Development Result of E-learning Website "Eduframe"

The E-learning website is designed using the ADDIE development model. Its project-based learning style aims to develop computational thinking skills.

3.1.1. Analyse

This phase encompasses two primary components. The first involves a content needs analysis, which entails identifying materials aligned with the syllabus to establish specific learning objectives and outcomes. In this study, consistent with the independent curriculum for Phase F of Software Engineering (RPL) in the web programming subject, the learning objectives require students to demonstrate the ability to apply frameworks in the development of both static and dynamic websites. The second component focuses on analyzing functional and non-functional requirements to determine the necessary elements for system development and implementation. The functional requirements are outlined in Table 4

Table 4 Functional requirements

Admin	Teacher	Students
Login page	Login page	Login page
Manage Moodle E-learning website menu	Manage teacher and student accounts	Access to view learning topics
Manage user roles	Manage learning topics	Access to take attendance
Manage courses	Manage attendance	Access to collect assignments
Manage plugins	Manage assignments	Taking quizzes
-	Manage quiz bank	Access to view assessment results
-	Manage assessments	Access to participate in discussions
-	Manage the discussion forum.	Access to update project progress
-	Manage project progress	-

Meanwhile, non-functional requirements for researchers are divided into two categories, including hardware and software requirements, as listed in Table 5

Table 5 Non-functional requirements on Moodle E-learning

Software	Hardware
OS Windows 11 64-bit	Laptop Lenovo IdeaPad Gaming 3i
Laragon	RAM 16 GB DDR 4
Visual Studio Code	SSD 1TB
Microsoft Edge	VGA Nvidia GTX 1080 Ti
Moodle	-

3.1.2. Design

The design stages carried out on Moodle are as follows: a use case diagram with three actors: students, teachers, and admins. Eduframe E-learning website flowchart has three roles, namely students, teachers, and admins, and the last is website display design.

3.1.2.1. Use Case Diagram

A use case diagram involving three actors, admin, student, and teacher, illustrates the interactions among these roles within the Task Management System (TMS), as depicted in Figure 2. For the admin actor, several potential use cases are identified, including managing CRUD operations for project progress, adding quizzes and assignments, overseeing attendance, grading activities, monitoring and analyzing students' grade progress, managing Moodle accounts, and organizing new courses.

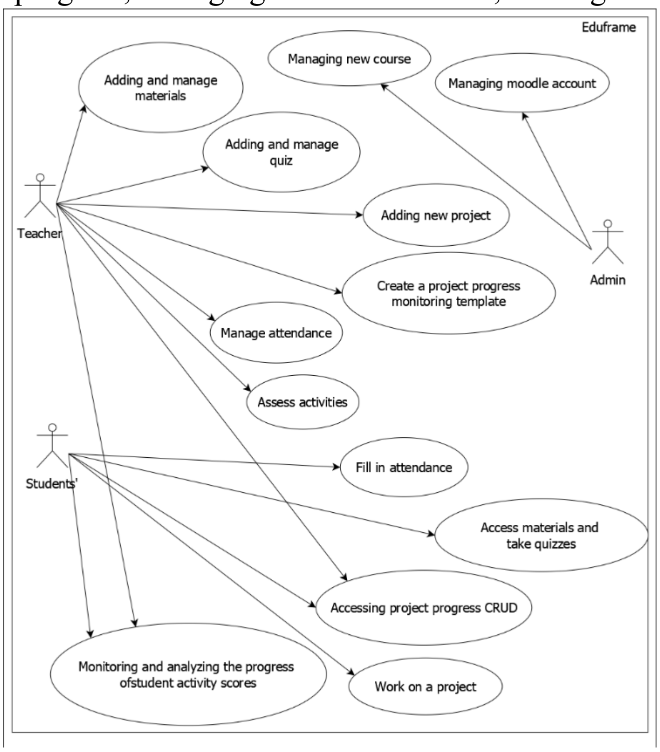

Figure 2 *Use case diagram (admin, teacher, student)*

Then, for teacher actors, some of the user cases may include managing CRUD progress projects, adding quizzes, adding assignments, managing attendance, grading activities, and viewing and analyzing student activity grade progress. As for student actors, some user cases may include accessing the CRUD progress projects, taking attendance, viewing and analyzing the progress of student activity grades, submitting assignments, and taking quizzes.

3.1.2.2. Initial design of "Eduframe" E-learning Website

The design of the Eduframe E-learning Website that is used by admin, teachers, and students is done at the beginning of the research to help visualize ideas and design concepts before the development begins. As presented in Figure 3, in the shared board, there is a lock board columns menu that functions to lock the board so that it cannot be moved or shifted. Second, there is a create template function for teachers to create a board that has been compiled and made a template so that it is easy to save a predetermined board framework. Third, there is a show template menu, which displays previously created templates, and finally, there is a delete board menu, which functions to delete unused boards. In Figure 3, there are also differences between students and teachers. The difference is that teachers can add boards by clicking the plus icon next to the desired board.

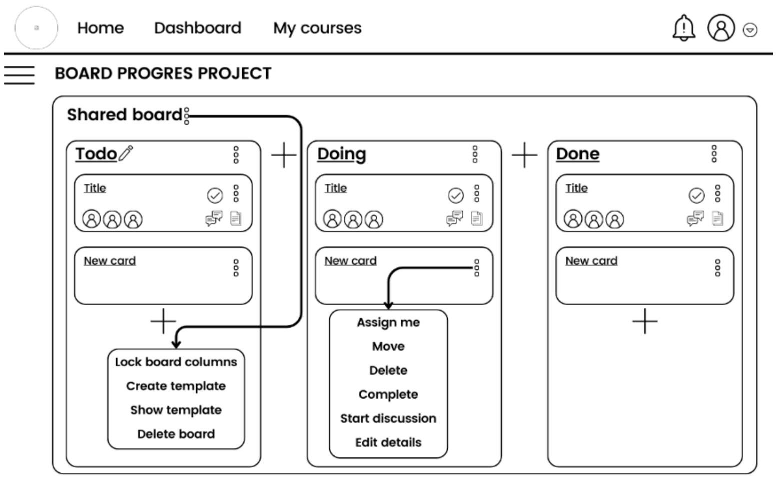

Figure 3 Board progress project

The display in Figure 4 shows the teacher opening the Edit details menu. This menu has a form similar to a student's, but the assignment section is different. In this menu, the teacher can directly assign cards to students who take the course (Task Management System).

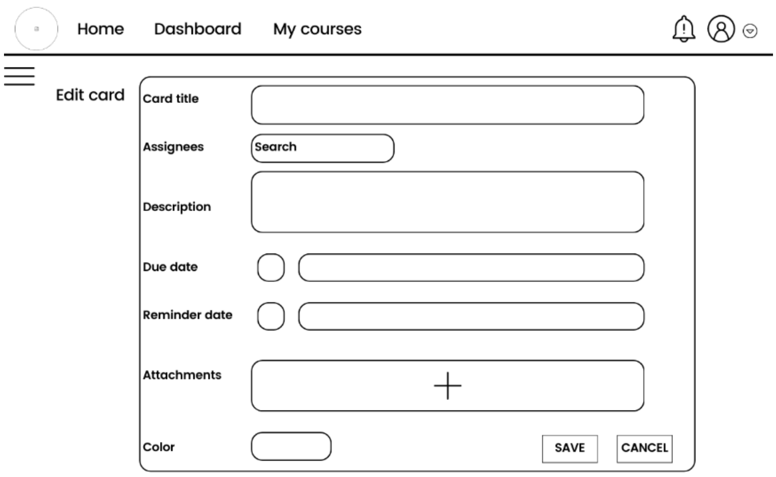

Figure 4 Edit card form

3.1.3. Development

This research develops a TMS (Task Management System) as a learning platform to hone students' computational thinking skills in learning the implementation of the Bootstrap 5 framework, especially in web programming subjects accompanied by a Project Based Learning style (Karmila *et al.*, 2022). This TMS was created using the Moodle platform and uses Cloud services to provide benefits in terms of scalability, data security, and access availability. This Moodle platform supports more effective teaching and sustainable use in educational environments and allows easy access for students and teachers without being limited by space and time, thus creating a more interactive and connected learning experience. The following Figure 5 and Figure 6 are E-learning website display designs that have been validated by expert lecturers and teachers. Figure 5 is the main page display when the user successfully enters the Username and Password correctly. On this page, users are presented with several features on the Navbar, and there is brief information about the importance of learning Framework implementation by using the Eduframe E-learning website that has been adapted to the current curriculum and using the Project Based Learning model.

Figure 5 The first display when the user successfully login

In Figure 6, there are features presented when student users open the Detail card, namely Assign Me to include themselves in the available Task, Move to move the Card between the Board that has been provided, Delete to delete the Card, Complete to mark that the task is considered complete, Start Discussion to start a conversation with the user involved in the Card, Edit Details to change the contents of the Card.

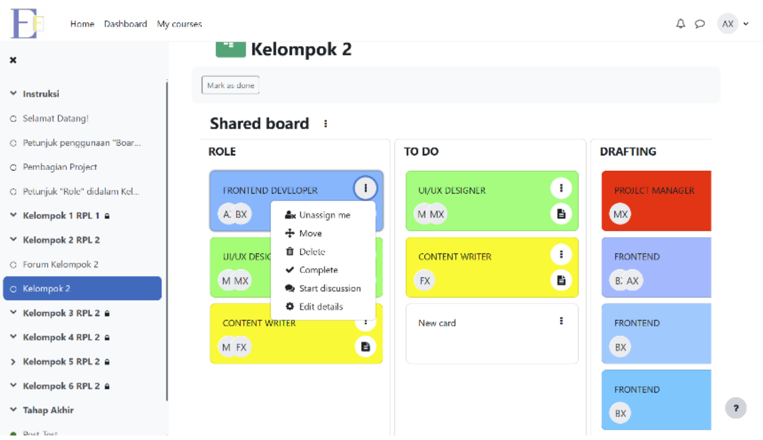

Figure 6 features available on each student's card

3.1.4. Implementation

The implementation phase is the fourth phase in the product development cycle, and it aims to test and evaluate the performance and effectiveness of the learning platform. In this research, the learning platform tested is an E-learning website specifically designed to support project-based learning in web programming. The testing was conducted at SMKN 2 Surabaya, involving two classes totaling 72 students. Class XI RPL 1 serves as the control class, while XI RPL 2 serves as the experimental class.

3.1.5. Evaluation

This evaluation is expected to ensure that the acquired media works well from a particular perspective and can also be used well in classroom learning experiences. The evaluation process includes various steps, such as technical tests to ensure the stability and reliability of the software or application used and its compatibility with available devices.

3.2. Discussion of Validation Results

Validation of the Eduframe E-learning website was carried out by lecturers from the Informatics Engineering Department of Surabaya State University and teachers from the Software Engineering Department (RPL) of SMKN 2 Surabaya.

3.2.1. Validation results of teaching modules or RPP

Based on the results of the RPP validation using 13 assessment indicators, where each indicator has a maximum value of 5, a total value of 111 was obtained from two independent validators.

$$Validity\ Score = \frac{111}{130} x100\% \ = 85\%$$

This calculation shows that the RPP has achieved a validity level of 85%, which means that this RPP is considered valid according to the established criteria.

3.2.2. Media validation results

Based on the results of media validation using 11 assessment indicators, each with a maximum value of 5, three independent validators obtained a total score of 150.

$$Validity\ Score = \frac{150}{165} x100\% \ = 90\%$$

This calculation shows that the Eduframe E-learning website achieves a validity level of 90%, indicating that this media is considered very valid according to the established criteria.

3.2.3. Material validation results

The material was validated using nine assessment indicators, each with a maximum value of 5. Two independent validators obtained a total score of 70.

$$Validity\ Score = \frac{70}{90} x100\% \ = 77\%$$

This calculation reveals that the learning material has achieved a validity score of 77%, which indicates that the material is considered valid according to the predetermined criteria.

3.2.4. Question validation results

The results of the validation of questions using 10 assessment indicators, each with a maximum value of 5, obtained a total score of 78 from two independent validators.

$$Validity\ Score = \frac{78}{100} x100\% \ = 77\%$$

This calculation shows that the post-test questions have a validity level of 78%, indicating that they are considered very valid according to the established criteria. Table 6 summarizes the conclusions of all validation results.

Table 6 Discussion of validation results

Validation Assessment	Validity	Description
RPP	85%	Very Valid
Media	90%	Very Valid
Material	77%	Valid
Question	78%	Valid

3.3. Test Results of Students Computational Thinking post-test scores

Another result that supports the success of this research is the analysis of post-test scores, which shows that the experimental class (XI RPL 2) that used the Eduframe E-learning website experienced an increase in post-test scores compared to the control class (XI RPL 1) that did not use the learning media. The average Computational Thinking post-test score in the experimental class reached 86.94, while in the control class, it was only 72.33. This data shows that the use of the Eduframe E-learning website has a positive effect on student's understanding of web programming materials.

3.3.1. Normality Test

The normality test was conducted to ensure that the data distribution of the Computational Thinking post-test scores of students from the experimental class (XI RPL 2) and control class (XI RPL 1) followed a normal distribution pattern. This is important to validate the use of certain parametric statistical analyses. This test was conducted using the Kolmogorov-Smirnov and Shapiro-Wilk methods. Considering the available sample data of 36 students, the Shapiro-Wilk test was used. Based on Figure Figure 7, the results show that the Computational Thinking post-test data from the experimental and control classes are normally distributed, as evidenced by a significance value greater than 0.05. This value can be used as a benchmark on the basis of the normality test decision (Kawuri *et al.*, 2019).

Tests of Normality

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Kelas	Statistic	df	Sig.	Statistic	df	Sig.
Hasil_Tes_Kognitif	Kelas Eksperimen	.164	36	.016	.943	36	.062
	Kelas Kontrol	.109	36	.200*	.965	36	.301

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Figure 7 Normality test (Computational thinking post-test score)

3.3.2. Homogeneity Test

The homogeneity test aims to determine whether the variance of the data on the Computational Thinking post-test scores of students in the experimental class (XI RPL 2) and the control group (XI RPL 1) is the same or homogeneous (Kawuri *et al.*, 2019). This test is carried out using the Levene test. Based on Figure 8, the results show that the variance of the Computational Thinking post-test scores of the experimental and control classes is homogeneously distributed, with a significance value of more than 0.05.

Test of Homogeneity of Variance

		Levene Statistic	df1	df2	Sig.
Hasil_Tes_Kognitif	Based on Mean	2.130	1	70	.149
	Based on Median	2.259	1	70	.137
	Based on Median and with adjusted df	2.259	1	68.383	.137
	Based on trimmed mean	2.090	1	70	.153

Figure 8 Homogeneity test (Computational thinking post-test score)

3.3.3. Hypothesis Test (Independent Sample T-Test)

Hypothesis testing was conducted to determine whether there was a significant difference between the Computational Thinking post-test scores of students from the experimental class, namely class XI RPL 2, which used the Eduframe E-learning website, and the control class, namely class XI RPL 1, which did not use the Eduframe E-learning website. The analysis used an independent samples t-test. The principle underlying the decision-making in hypothesis testing in this test is if sig. > 0.05, then H0 is accepte,d and if sig. < 0.05, then H1 is accepted (Kawuri *et al.*, 2019). Based on Figure 9, this value confirms the sig value. (2 tailed) <0.05, so there is a significant difference in the average post-test scores of the experimental and control classes.

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means				
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Hasil_Tes_Kognitif	Equal variances assumed	2.130	.149	8.018	70	.000	14.611	1.822
	Equal variances not assumed			8.018	66.043	.000	14.611	1.822

Figure 9 Hypothesis test (Computational thinking post-test score)

3.4. Test Results of Students' Computational Thinking Project Scores

The average Computational Thinking project score in the experimental class was also higher, at 86.94, compared to the control class, which only reached 75.06. This shows that Eduframe E-learning not only helps improve students' conceptual understanding of web programming but also has a positive impact on their skills. Students in the experimental class were better able to put the concepts they had learned into practice, showing better skills in designing websites. This improvement shows that the Project Based Learning (PJBL) method implemented through Eduframe E-learning has a positive impact on learning.

3.4.1. Normality Test

A normality test was conducted to ensure that the data distribution of students' Computational Thinking project scores from the experimental class (XI RPL 2) and control class (XI RPL 1) followed a normal distribution pattern. This is important to validate the use of certain parametric statistical analyses. This test was conducted using the Kolmogorov-Smirnov and Shapiro-Wilk methods (Kawuri *et al.*, 2019). Considering the available sample data of 36 students, the Shapiro-Wilk test was used. Based on Figure 10, the results show that the Computational Thinking project score data from the experimental and control classes are normally distributed, as evidenced by a significance value greater than 0.05 (Kawuri *et al.*, 2019). This value can be used as a benchmark on the basis of the normality test decision.

Tests of Normality

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Kelas	Statistic	df	Sig.	Statistic	df	Sig.
Hasil_Tes_Psikomotorik	Kelas Eksperimen	.148	36	.045	.941	36	.056
	Kelas Kontrol	.145	36	.053	.953	36	.127

a. Lilliefors Significance Correction

Figure 10 Normality test (Computational thinking project post-test score)

3.4.2. Homogeneity Test

The homogeneity test aims to determine whether the variance of student Computational Thinking project value data in the experimental class (XI RPL 2) and control group (XI RPL 1) is the same or homogeneous (Kawuri *et al.*, 2019). This test was carried out using the Levene test. Based on Figure 4.50, the results show that the variance of the Computational Thinking project scores of the experimental and control classes is homogeneously distributed, with a significance value of more than 0.05.

Test of Homogeneity of Variance

		Levene Statistic	df1	df2	Sig.
Hasil_Tes_Psikomotorik	Based on Mean	2.831	1	70	.097
	Based on Median	2.528	1	70	.116
	Based on Median and with adjusted df	2.528	1	65.396	.117
	Based on trimmed mean	2.738	1	70	.102

Figure 11 Homogeneity (Computational thinking project post-test score)

3.4.3. Hypothesis Test

Hypothesis testing was conducted to determine whether there is a significant difference between the Computational Thinking project scores of students from the experimental class, namely class XI RPL 2, which uses the Eduframe E-learning website, and the control class, namely class XI RPL 1, which does not use the Eduframe E-learning website. The analysis used an independent samples t-test. The principle underlying the decision-making in hypothesis testing in this test is if sig. > 0.05, then H0 is accepted, and if sig. < 0.05, then H1 is accepted (Kawuri *et al.*, 2019). Based on Figure 12, this value confirms the sig value. (2 tailed) <0.05, then there is a significant difference in the average value of the post-test of the experimental class and the control class, as presented in Figure 12.

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means				
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Hasil_Tes_Psikomotorik	Equal variances assumed	2.831	.097	6.526	70	.000	11.889	1.822
	Equal variances not assumed			6.526	65.668	.000	11.889	1.822

Figure 12 Hypothesis test (Computational thinking project post-test score)

4. Conclusions

From the results obtained, discussion, and review of research that aims to improve students' Bootstrap 5 framework programming skills in learning web programming through the development of website-based E-learning learning media called Eduframe, the following conclusions can be drawn. This research successfully designed and implemented a Task Management System (TMS) based on Moodle E-learning that suits the learning needs of web programming subjects in class XI RPL at SMKN 2 Surabaya. The implementation results show that the system is able to facilitate task management, progress monitoring, and interaction between teachers and students effectively, thus supporting the project-based learning process well. The use of TMS based on Moodle E-learning has proven to be effective in improving students' computational thinking skills. The analysis showed a significant change in students' computational thinking ability before and after the use of TMS. With the TMS, students become more organized in completing assignments and projects, which contributes to an improved understanding of programming concepts and the ability to solve problems systematically.

Based on the findings of this research, there are some suggestions for further development and implementation of Eduframe E-learning website learning media. For further development, it is suggested that the implementation of the TMS (Task Management System) is continuously updated in accordance with technological developments and student needs. Additional features, such as integration with online collaboration tools or more detailed tracking of student progress, can be added to further maximize the learning experience. In addition, training and mentoring for teachers in the use of this system should be carried out regularly so that the utilization of TMS in learning is more optimal. Based on the results of the study that showed an increase in students' computational thinking ability, it is recommended that TMS be adopted more widely in other subjects that require the completion of complex projects or tasks. In addition, it is necessary to conduct further research to monitor the long-term effects of using TMS on the development of students' computational abilities and problem-solving skills. Further research could also explore the impact of TMS on students' motivation and engagement in learning.

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